Mu Division  

Topic Test 2  

Computer Science  

Mu Alpha Theta National Convention  
Chicago 1998
General Instructions:
Unless otherwise stated all answers should be written as decimals.
If you are asked to give your answer as a fraction, please give your answer in $a/b$ form
where $a$ and $b$ are relatively prime.

Questions

1. Simplify and leave your answer in base 8.
   \[
   \frac{111_{(2)} \times 444_{(8)} \times 888_{(16)}}{111_{(16)}}
   \]

2. How many bit strings of length 5 satisfy the following equation?
   \[(10110 \text{ OR } X) \text{ AND } (01100 \text{ OR } 10101) = 11100\]

3. Evaluate the following prefix expression
   \[ + * 3 5 - 7 4 / * 9 2 6 \]

4. How many ordered 4-tuples of binary inputs (A, B, C, D) make X true?

5. Evaluate $f(2751)$, given
   \[
f(x) = \begin{cases} 
   x & \text{if } x < 5 \\
   10 \times f(x \text{ DIV } 5) + x & \text{if } x \geq 5
   \end{cases}
   \]
6. Suppose the words "Gatlinburg", "Tenn", "Next", and "Year" were used as input to produce a binary search tree. How many different orderings would produce the tree below?

```
N
/ \
/   \
G   T
   / \
   /   \
   Y   
```

7. Assume that the input line is the character string "135274". What is the output of the following program segment?

```plaintext
while not eoln(F) do
  begin
    read (F, ch);
    if eoln(F) then
      write("");
    else if ch < '5' then
      write(ch);
  end;
```

8. What are the first 5 non-zero digits in the base 8 expansion of the base 8 fraction 5/6?

9. Given \( f(x, y) = \begin{cases} 
  x + f(x + 1, y) & \text{if } x \text{ is odd and } x > 0 \\
  y + f(x/2, y - 3) & \text{if } x \text{ is even and } y > 0 \\
  2x + y & \text{otherwise}
\end{cases} \)
Find the value of $f(17,8)$.

What is the output of the following program? Assume that the numbers are output without any blanks between them.

```pascal
program test;

var
  x,y: integer;

function min(x,y:integer):integer;
  begin
    if (x < y) then min := x
    else min := y;
  end;

procedure OhWell(var x:integer; y:integer);
  begin
    x := x + y;
    y := y + 2;
    write(y);
  end;

procedure OhOh(x:integer; var y:integer);
  begin
    x := x DIV 2;
    y := min(x,y);
    write(x);
    OhWell(y,x);
  end;

begin
  x := 6;
  y := 3;
  OhWell(x,y);
  OhOh(y,x);
  write(x);
  write(y);
end.
```

Let X be a binary bit string of length 5. How many different values of X satisfy the equation:

$$X \text{ AND } (10011) \text{ OR } 10100 = 10110$$
12. What is the output of the following program?

    program test;

    var count: integer;

    function buildAns(myString: string; myChar: char): integer;
    var count, answer: integer;
    begin
        answer := 0;
        for count := 1 to length(myString) do
            if myString[count] = myChar then
                answer := answer + 4
            else
                answer := answer + 2;
        buildAns := answer;
    end;

    procedure checkAns(answer: integer);
    begin
        while answer > 1 do
            begin
                if answer MOD 2 = 0 then write('x')
                else write('y');
                answer := answer DIV 2;
            end;
        end;

    begin
        count := buildAns("MU_ALPHA_THETA", 'A');
        checkAns(count);
    end.

13. What is the sum of the numerator and denominator of the following fraction when it is written in base 10 and simplified?
    \[
    \left( \frac{0.7A_{16}}{0.7_{(8)}} \right) / 0.0101_{(2)}
    \]

14. Consider the following functions defined on binary bit strings:
    rShift-n = shifts the bits n-places to the right and fills in the beginning with 0's
    rCircle-n = remove the rightmost n bits and place them at the beginning of the string.
    lShift-n = the same as rShift-n only move left.
    lCircle-n = the same as rCircle-n, only circle left.
    Evaluate the expression:
    \[rCircle-2 \left( rShift-1 \left( 10101 \right) \text{ OR } lCircle-2 \left( 10110 \right) \right)\]
15. What is the value of the following prefix expression, if \( a = 5 \), \( b = 3 \) and \( c = 2 \)?

\[
/*\ a\ +\ b\ -\ *\ c\ a\ b\ c
\]

16. Simplify the following boolean expression:

\[
(x + y)(\overline{z} x)
\]

17. What is the output of the following program if the input data is:

25, 16, 31, 41, 20, 1, 0, 3, -15?

```pascal
program test;
var m, n: integer;
begin
  m := 0;
  repeat
    read(n);
    if NOT(n MOD 2 = 0) then
      m := m + n;
  until n < 0;
  writeln(m);
end.
```

18. If the following tree is traversed in postorder, what is the order of the output?

```
  X  
 / 
Y   
```

19. What is the maximum internal path length of a binary tree that contains 15 nodes?

20. A heap is implemented using a binary tree. If the heap is created using the string “Computer_Science_Rocks”, how many leaves are in the tree?